Georgia Tech Research in Support of CDA at LAX

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Georgia Tech CDA Research Team

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Design Methodology

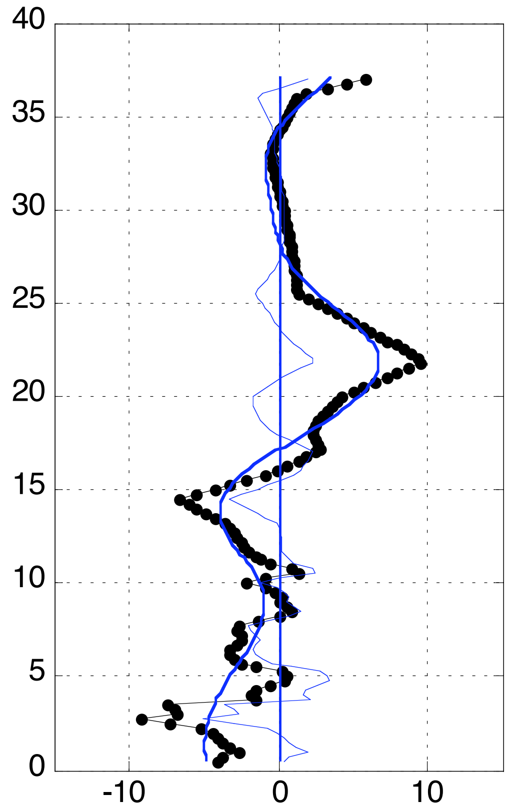
- Determine lateral profile
- Build wind model
  - Develop separate model for each definable subset of wind conditions
- Use TASAT to determine:
  - Range of crossing altitudes (at each waypoint) for each aircraft type in unrestricted descent from cruise
  - Required separation at (or near) top-of-descent and at transition altitude for each pair of aircraft types in unrestricted descent from cruise

Design Methodology (cont'd)

- Develop (if airspace is constrained) set of scenarios with different transition altitudes and waypoint (altitude and speed) restrictions
- Use TASAT to determine:
  - Required separation at (or near) top-of-descent and at transition altitude for each pair of aircraft types
- Determine "best" transition altitude, waypoint restrictions and required separations given:
  - Trade-off (if any) between noise, emissions, fuel burn and throughput

Wind Model

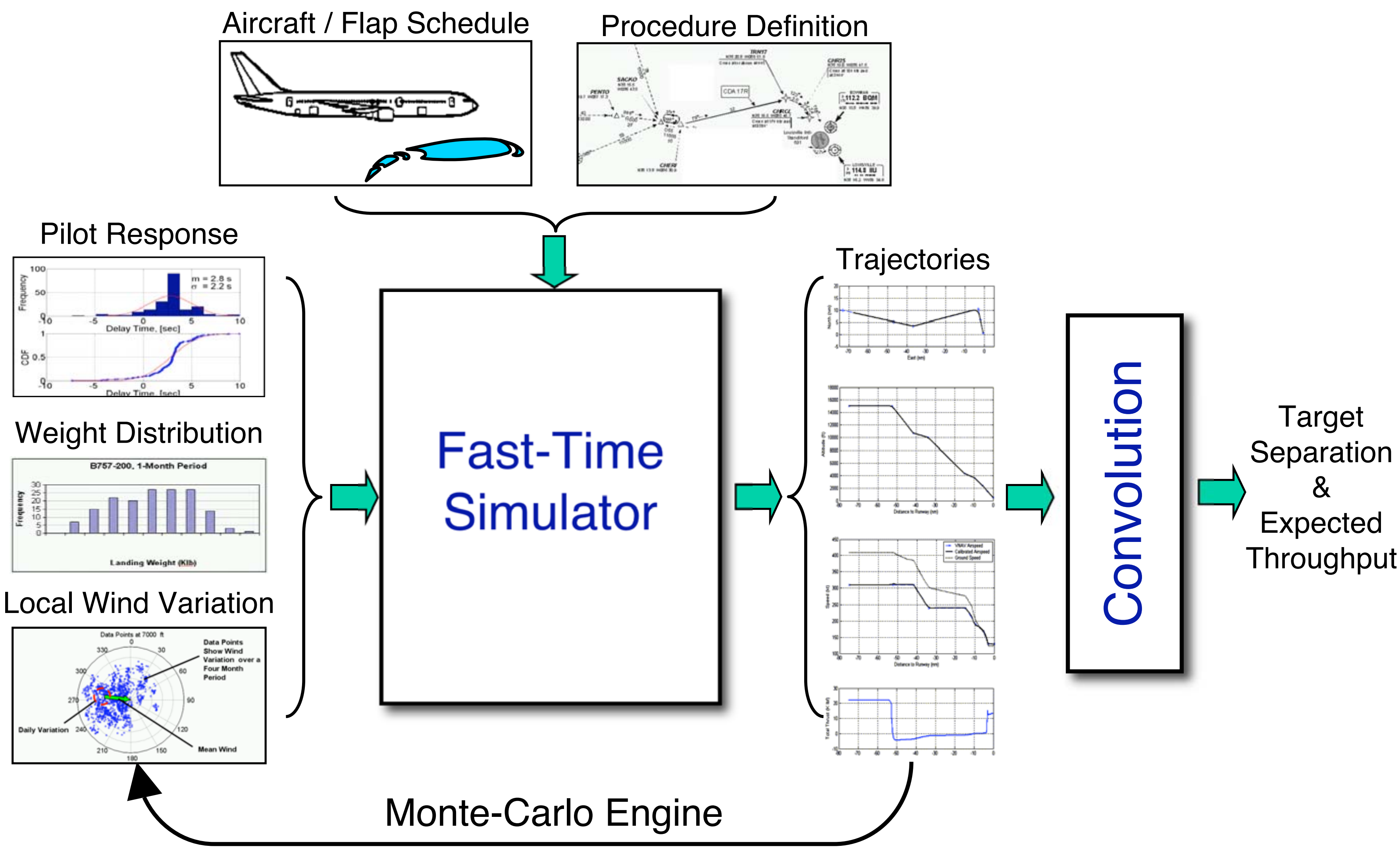
Mode decomposition and Auto-Regression modeling



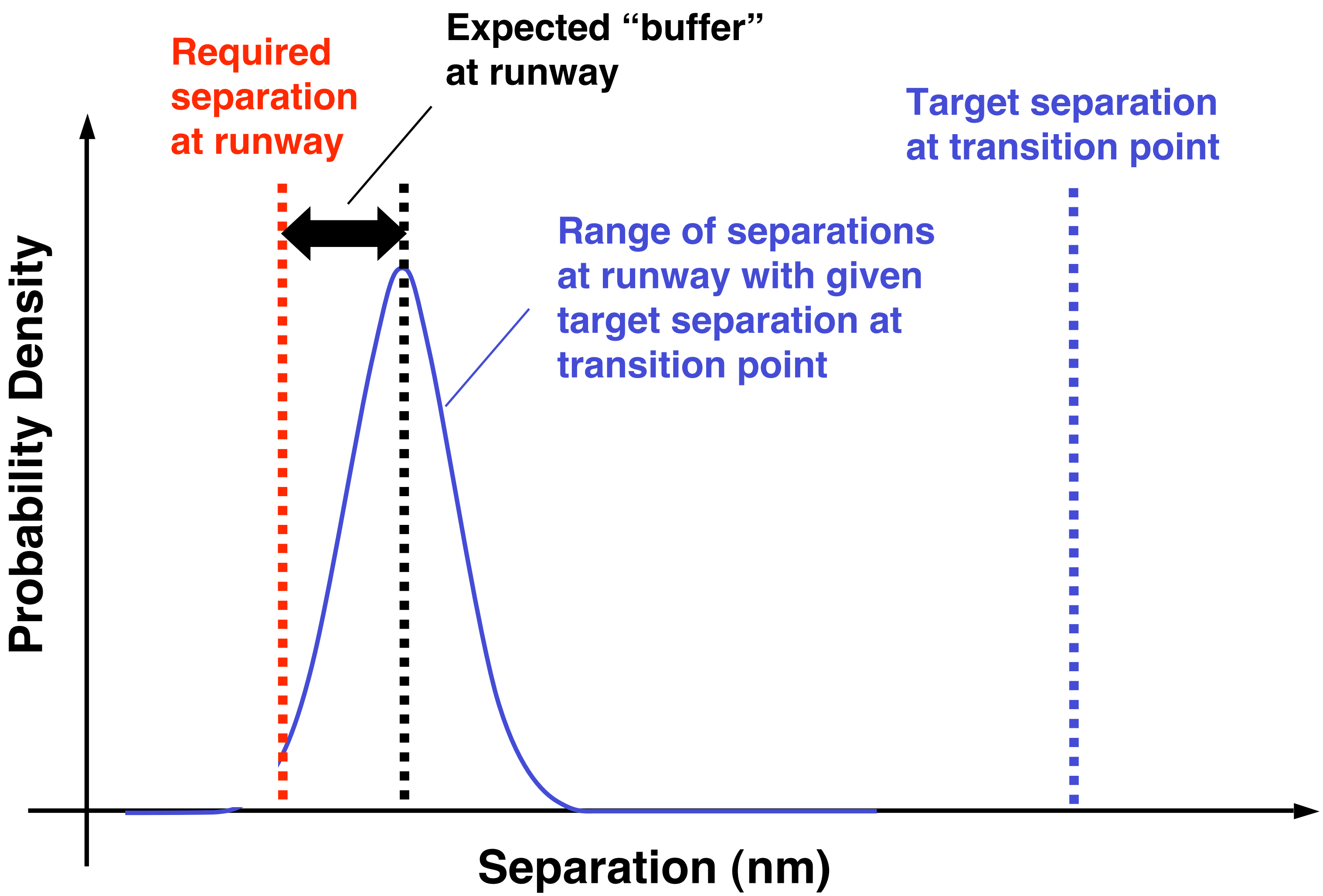
TASAT

- Monte Carlo Simulation-based Tool for the Analysis of Separation and Throughput (TASAT) where aircraft trajectory…
  - Lateral position
  - Altitude
  - Speed
  - Thrust setting
  - Speed brake setting
  - Flap setting
  - Landing gear position
- Computed versus time with uncertainties in…
  - Wind
  - Aircraft weight
  - Pilot behavior

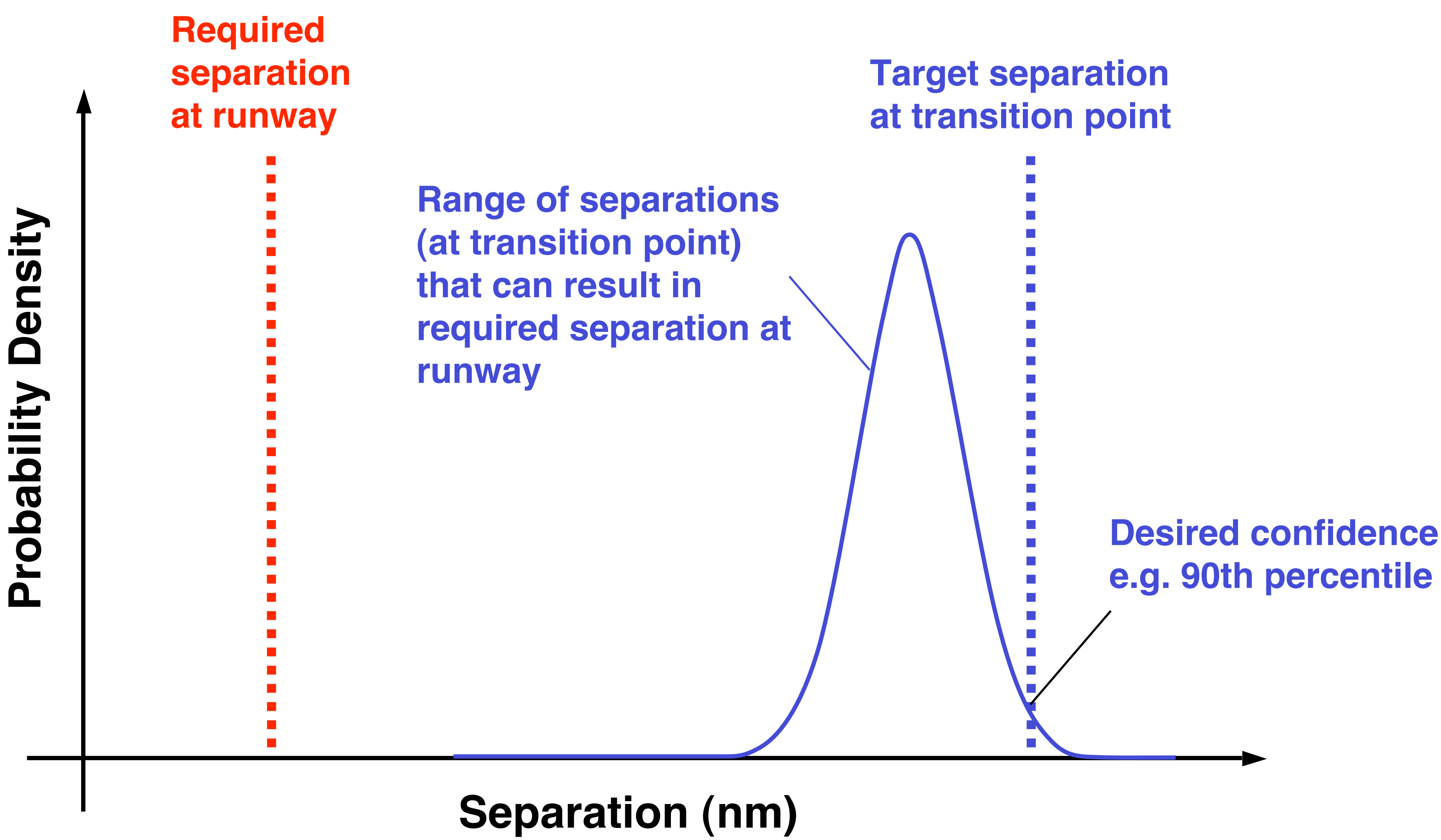
TASAT


Aircraft / Flap Schedule
Procedure Definition
Pilot Response
Delay Time, [sec]
Frequency
CDF
Weight Distribution
B757-200, 1-Month Period
Landing Weight (Klb)
Local Wind Variation
Data Points at 7000 ft
Data Points Show Wind Variation over a Four Month Period
Daily Variation
Mean Wind
Fast-Time Simulator
Trajectories
Convolution
Target Separation & Expected Throughput
Monte-Carlo Engine

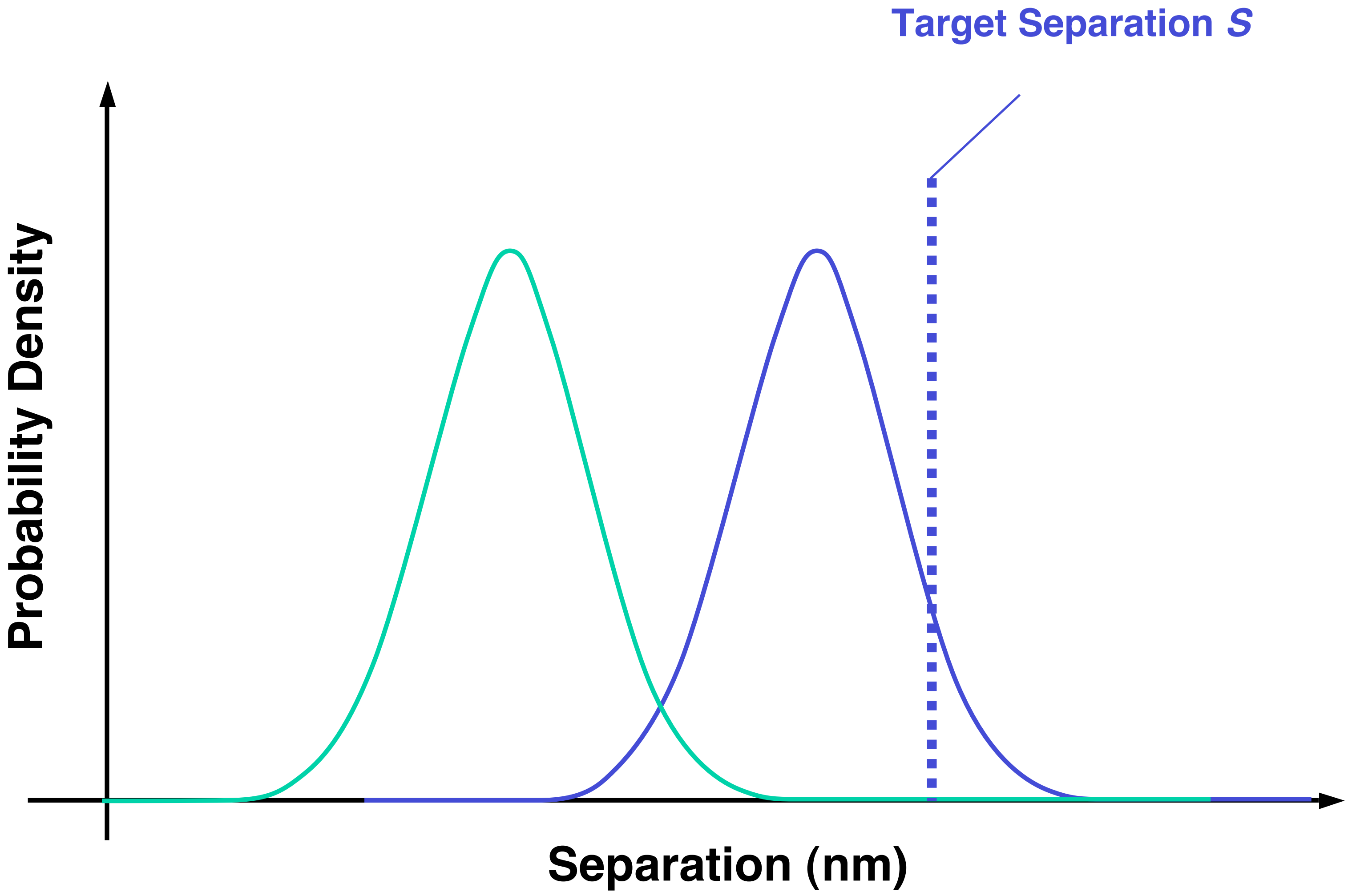
Throughput Analysis Methodology



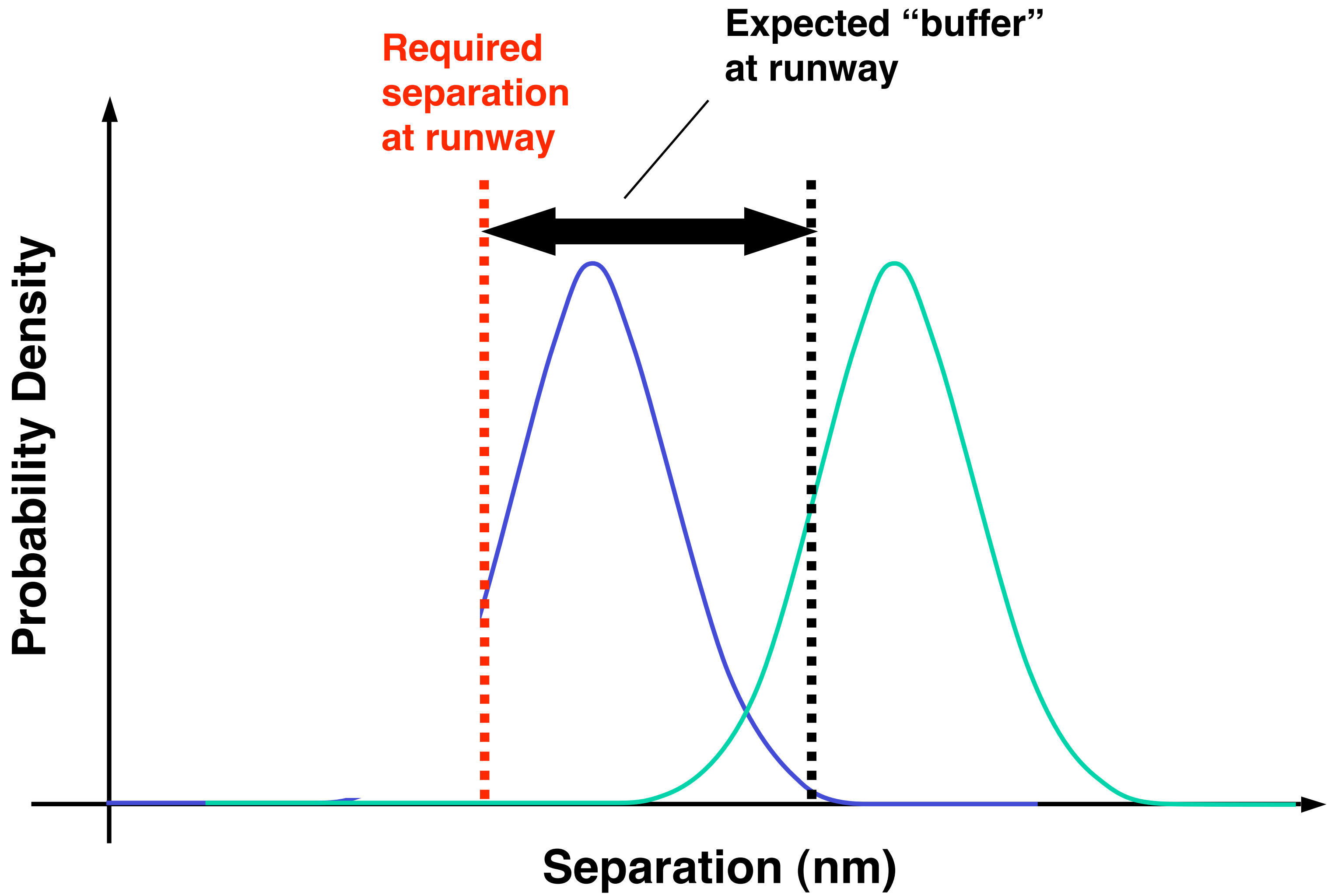
Separation Analysis Methodology



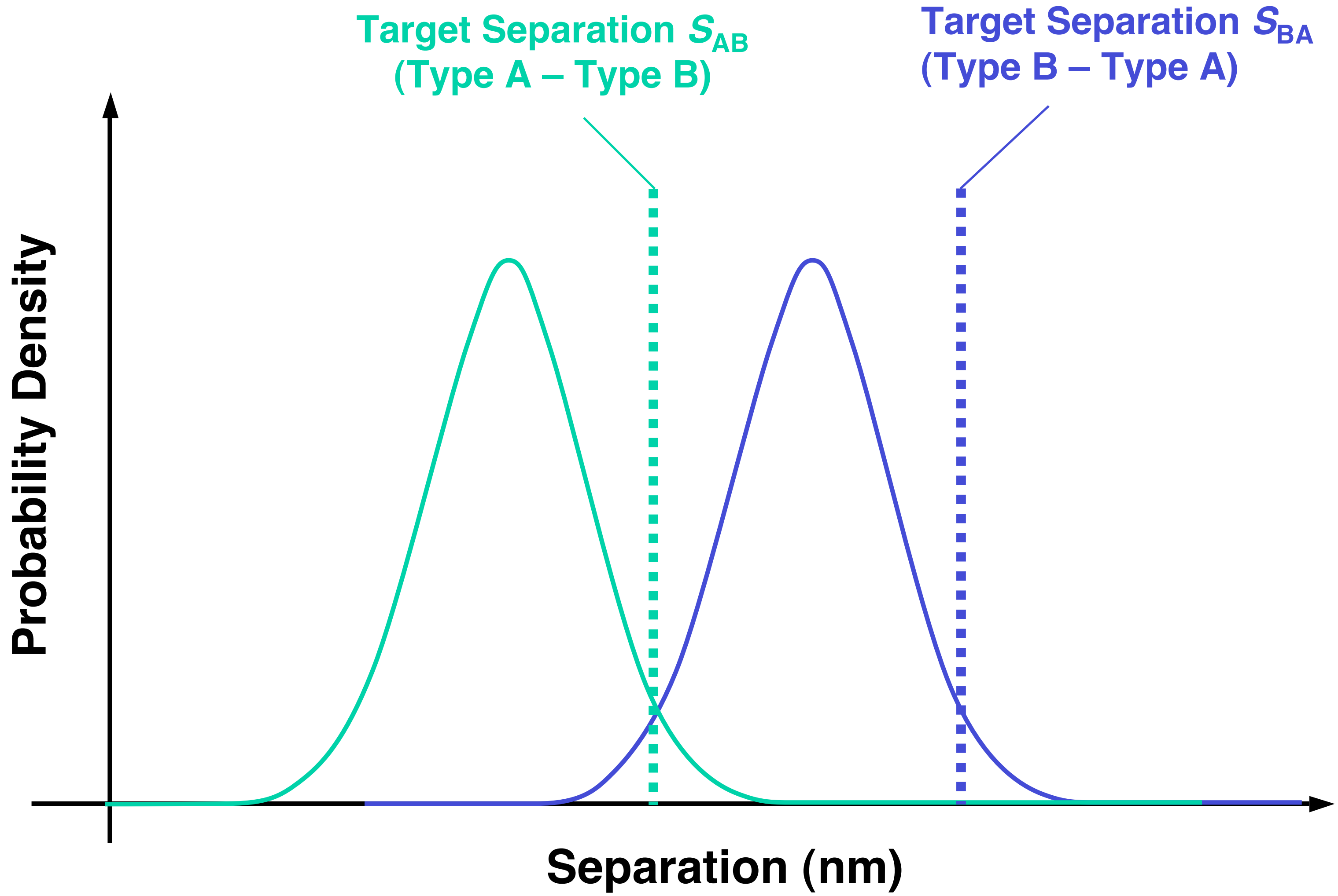
Benefit of Segmentation



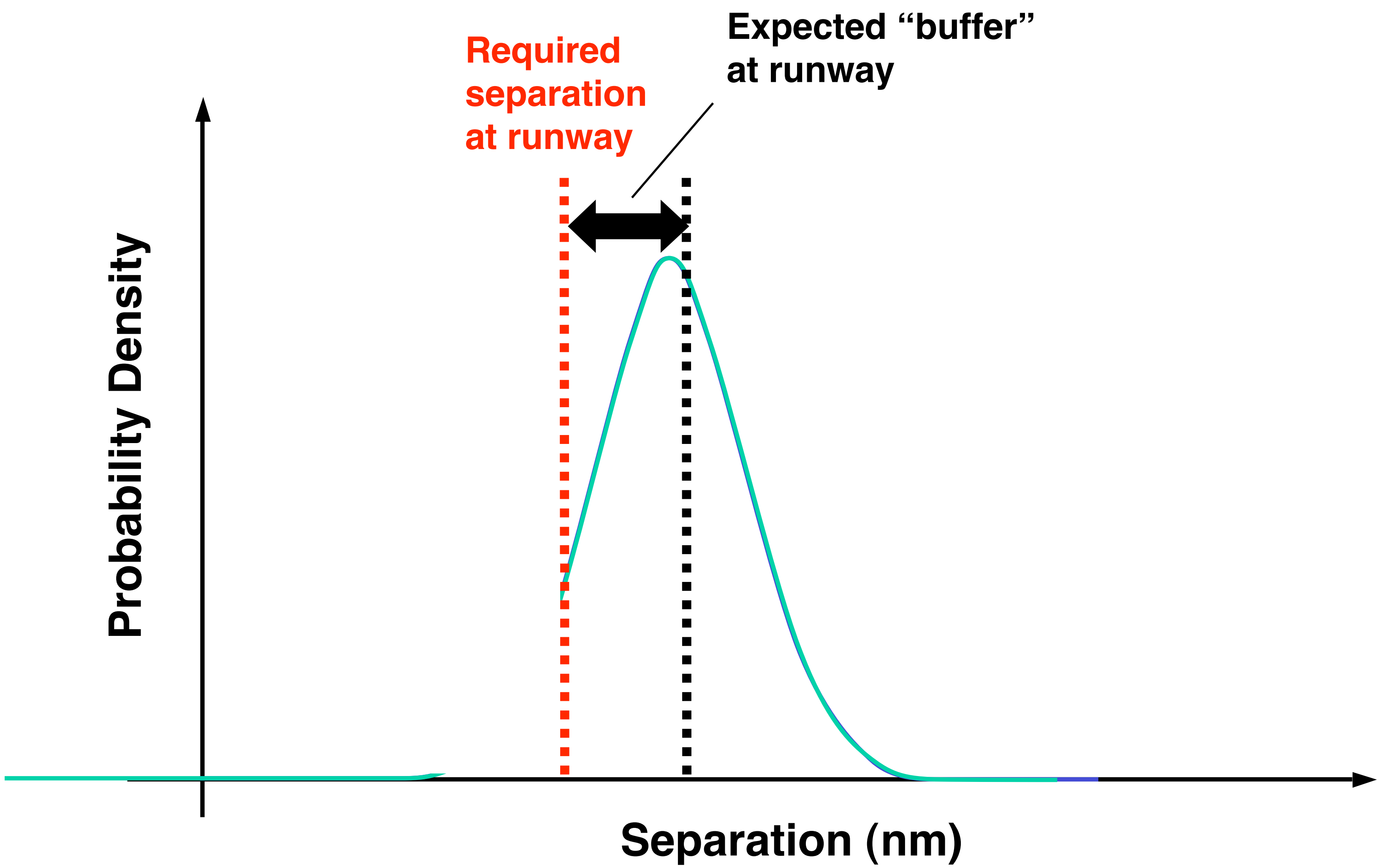
Benefit of Segmentation (cont'd)



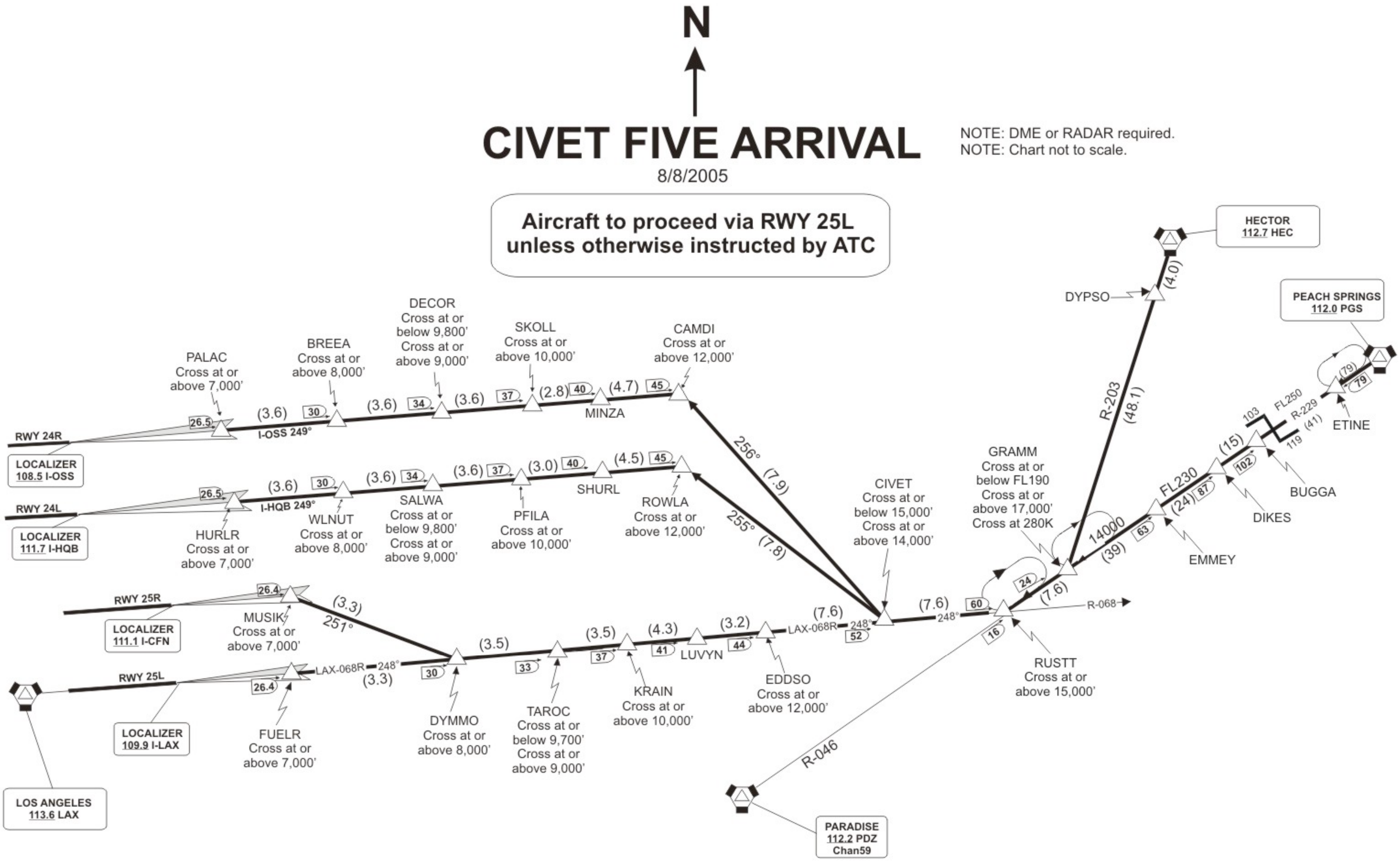
Benefit of Segmentation (cont'd)



Benefit of Segmentation (cont'd)



CIVET Arrival



CIVET Analysis

- Transition point assumed to be GRAMM
  - Waypoint where Los Angeles Center “handoffs” aircraft to Southern California TRACON
- Wind model developed using ACARS data from LAX arrivals
  - Wind data separated into bins based on the magnitude and sign of the wind component along the runway axis
  - Separate model built for each 20 knot bin between -110 and +110 knots

Separation & Throughput

Separation Required at Threshold (nm)

Instrument Flight Rules (IFR)

Trailing Aircraft \ Leading Aircraft	L	757	H
L	2.5	5	5
H	2.5	4	4

Separation & Throughput

- Determined target separation at GRAMM as a function of
  - Desired confidence
    - Three confidence levels: 70%, 80%, 90%
    - Given: no wind, no restrictions and under IFR
  - Wind speeds
    - Three wind speeds: -100 (±10) knots, 0 (±10) knots, +60 (±10) knots
    - Given: 70% confidence, no restrictions and under IFR

Separation & Throughput (cont'd)

no wind, no restrictions, under IFR

Separation Required at GRAMM (nm)

to be 70% Confident that Separation at Runway Greater Than Required Separatio n

Leading Aircraft

Trailing Aircraft

	L	757	H
L	8.5	14.25	15.5
H	9.5	12.75	14

Separation & Throughput (cont'd)

no wind, no restrictions, under IFR

Separation Required at GRAMM (nm)

to be 80% Confident that Separation at Runway Greater Than Required Separatio n

Leading Aircraft

Trailing Aircraft	L	757	H
L	9	14.5	15.75
H	9.75	13	14

Separation & Throughput (cont'd)

no wind, no restrictions, under IFR

Separation Required at GRAMM (nm)

to be 90% Confident that Separation at Runway Greater Than Required Separatio n

Leading Aircraft

Trailing Aircraft

	L	757	H
L	9.25	14.75	16
H	10	13.25	14.5

Separation & Throughput

- Determined target separation at GRAMM as a function of
  - Desired confidence
    - Three confidence levels: 70%, 80%, 90%
    - Given: no wind, no restrictions and under IFR
  - Wind speeds
    - Three wind speeds: -100 (±10) knots, 0 (±10) knots, +60 (±10) knots
    - Given: 70% confidence, no restrictions and under IFR

Separation & Throughput (cont'd)

70% confidence, no restrictions, under IFR

Separation Required at GRAMM (nm)

when wind at 30,000 ft is -100 (±10) knots

Leading Aircraft

Trailing Aircraft

	L	757	H
L	7.25	13.5	14
H	8	11.5	12.25

Separation & Throughput (cont'd)

70% confidence, no restrictions, under IFR

Separation Required at GRAMM (nm)

when wind at 30,000 ft is 0 (±10) knots

Leading Aircraft

Trailing Aircraft

	L	757	H
L	8.5	14.25	15.5
H	9.5	12.75	14

Separation & Throughput (cont'd)

70% confidence, no restrictions, under IFR

Separation Required at GRAMM (nm)

when wind at 30,000 ft is +60 (±10) knots

Leading Aircraft

Trailing Aircraft

	L	757	H
L	9.25	15.50	17.50
H	9.75	13.50	15.25

Conclusions

- Required separations are similar in distance to current separations…
  - Currently aircraft are approximately 10 miles-in-trail at GRAMM until SCT begins to get overloaded and then 15 miles-in-trail thereafter
- Except that we apply separation on the basis of the pairing of the aircraft classes